

[54] **APPARATUS FOR REMOTE HANDLING OF MATERIALS**

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[51] Int. Cl. B01f 11/00, B01f 1/00, G01n 31/12

[58] Field of Search 23/253 PC, 253 R, 259; 312/209, 304; 259/72; 356/85, 197

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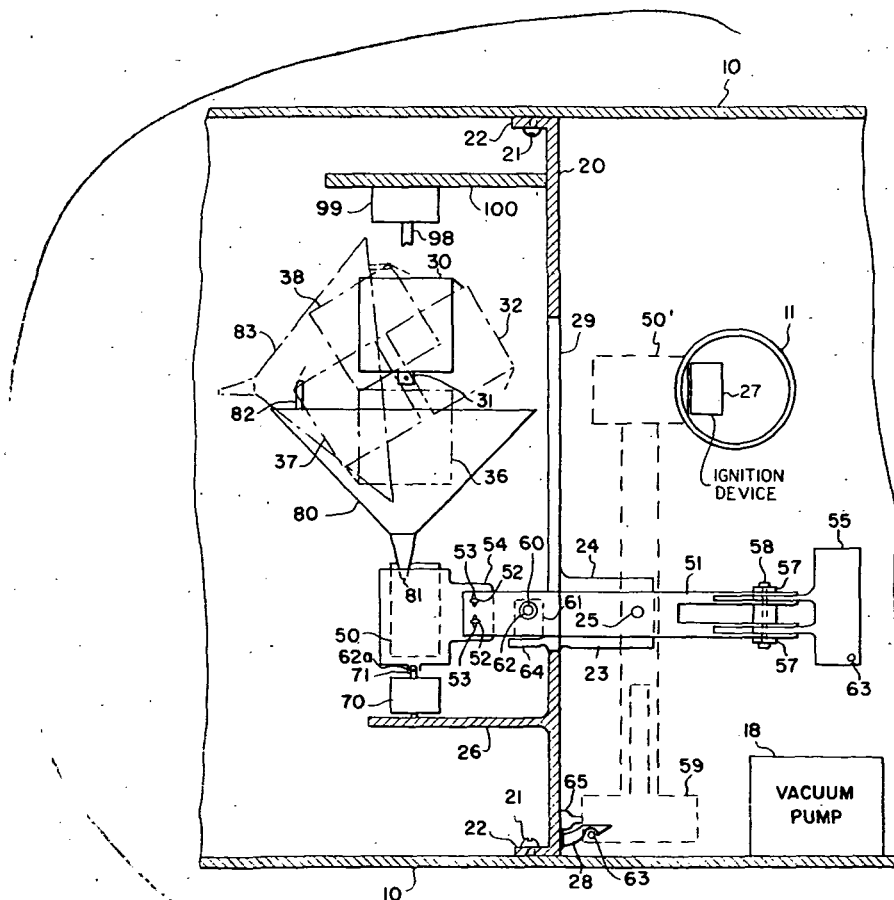
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[57] **ABSTRACT**

Apparatus for remote handling of materials. A closed housing is provided with first and second containers and first and second reservoirs for holding materials to be mixed. The materials are transferable from the reservoirs to the first container; in which they are mixed. The mixed materials are then conveyed from the first container to the second container preferably by dumping the mixed materials into a funnel positioned over the second container. The second container is then moved to a second position for analysis of the mixed materials. For example, the materials may be ignited and the flame analyzed. Access, such as a sight port, is provided in the housing at the analysis position. The device provides a simple and inexpensive apparatus for safely mixing a pyrophoric material such as barium metal and an oxidizer such as molybdenum trioxide which together form a thermite type mixture that burns to produce a large quantity of heat and light.

26 Claims, 7 Drawing Figures



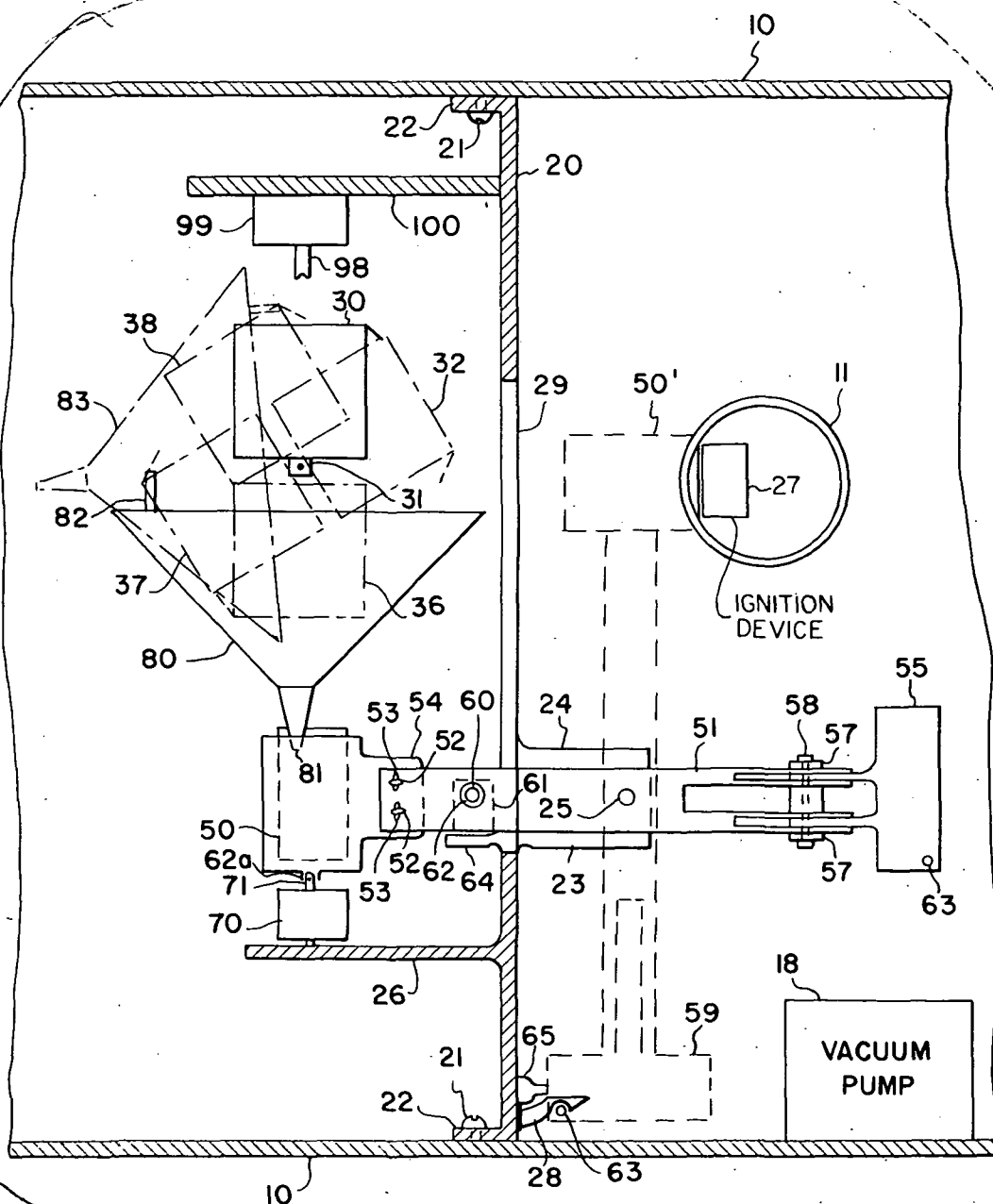


FIG. 1 3,790,347

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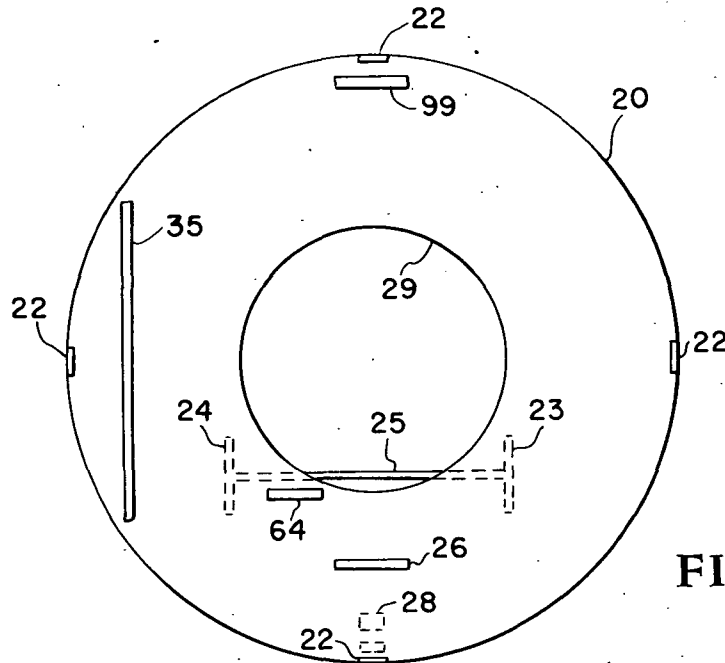


FIG. 2

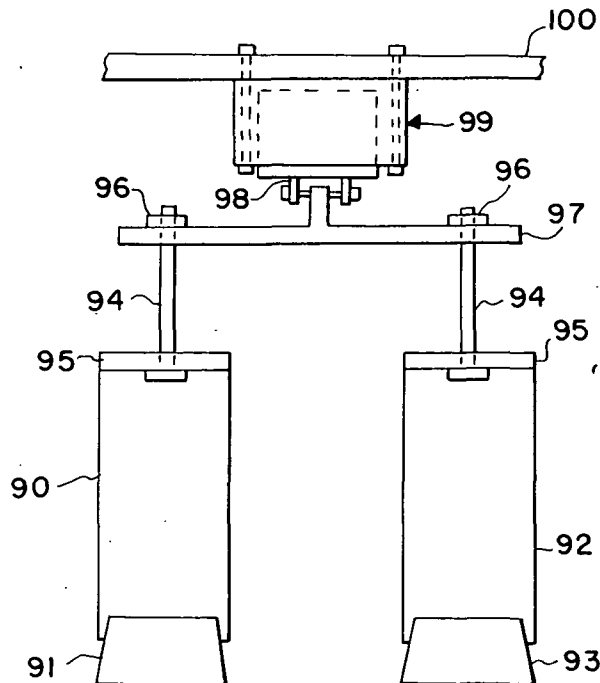


FIG. 3

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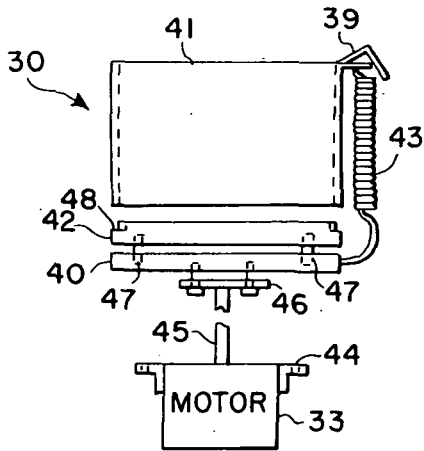


FIG. 4

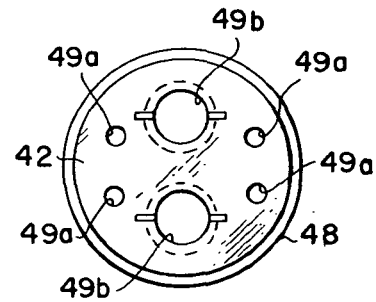


FIG. 4a

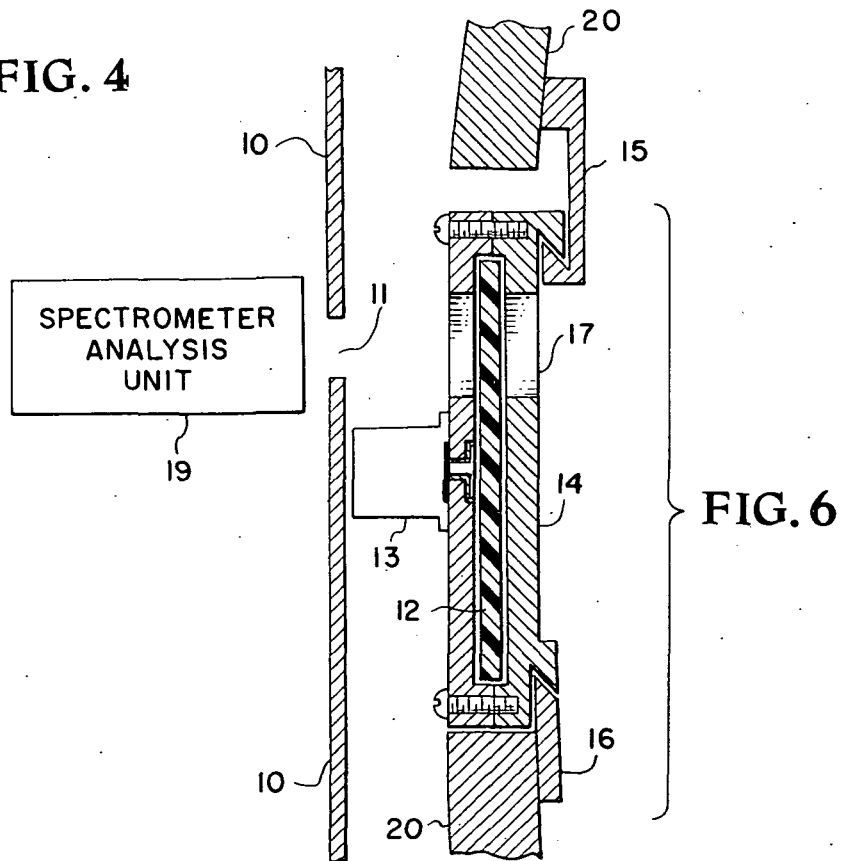


FIG. 6

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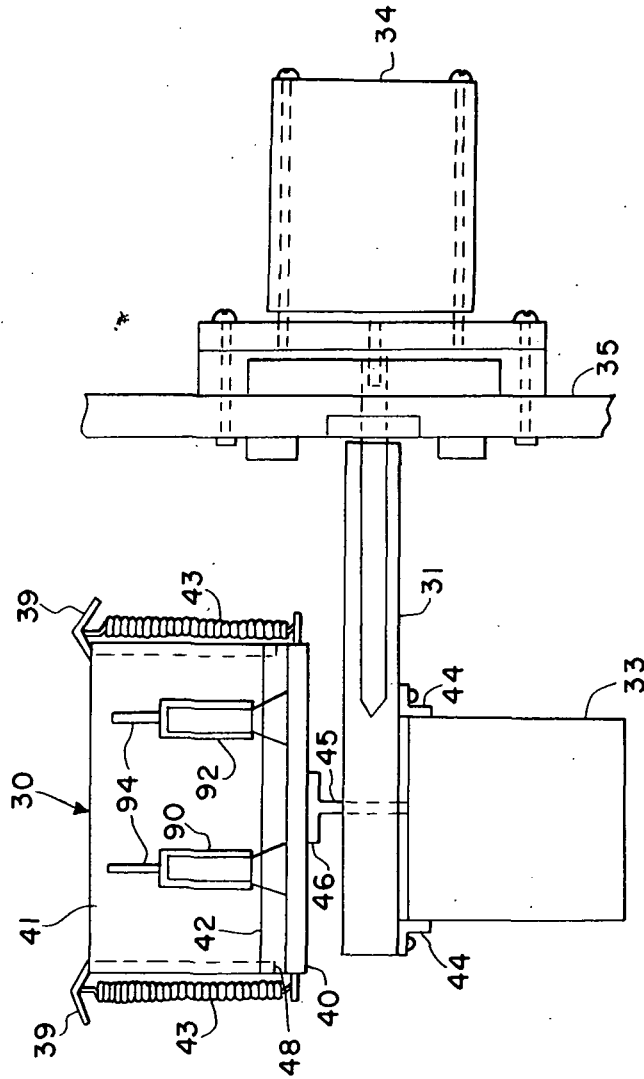


FIG. 5

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APPARATUS FOR REMOTE HANDLING OF MATERIALS

ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 STAT. 435; 42 U.S.C. 2457).

BACKGROUND OF THE INVENTION

This invention relates to remote handling apparatus. More particularly, the invention relates to apparatus for the remote mixing of chemicals, particularly hazardous solid chemicals.

There is a need for simple, efficient, reliable and inexpensive remote handling devices. For example, in order to analyze a thermite type mixture of barium metal and molybdenum trioxide, it is necessary to place these two materials in intimate contact and mix thoroughly, transfer the mixed materials to a test chamber, and position the test chamber for analysis, such as by test firing. Barium metal which is pyrophoric, can spontaneously ignite in the presence of oxygen.

It is an object of the present invention to provide novel remote material handling apparatus. It is still a further object of the invention to provide a simple, efficient, reliable and inexpensive remote handling apparatus. It is still a further object to provide such apparatus for mixing two or more materials, transferring the mixed materials to a test chamber, and to position the test chamber for analysis of the mixed materials.

SUMMARY OF THE INVENTION

The foregoing objects of the present invention are achieved by providing apparatus for the remote handling of materials comprising a closed housing, a first reservoir as a means for storing a first material in the housing, a second reservoir as a means for storing a second material in the housing, or more reservoirs for additional materials it is desired to mix, a first container for mixing the first and second materials, a means for transferring the first and second materials from the first and second reservoirs, respectively, to the first container, a means for mixing the first and second materials in said first container, a second container for receiving mixed materials and moveably mounted within said housing for moving from a material receiving position to a material analysis position, both of the positions being within the housing, means for transferring the mixed materials from the first container to the second container when said second container is positioned at the material receiving position, and means for moving the second container from the material receiving position to the material analysis position to bring the mixed materials into the material analysis position.

DETAILED DESCRIPTION

There follows a detailed description of a preferred embodiment of the invention, together with accompanying drawings. However, it is to be understood that the detailed description and accompanying drawings are provided solely for the purpose of illustrating a preferred embodiment and that the invention is capable of numerous modifications and variations that will be

readily apparent to those skilled in the art without departing from the spirit and scope of the invention.

FIG. 1 is a diagrammatic elevation view, partially broken away and partially in section, of remote handling apparatus of the present invention;

FIG. 2 is a diagrammatic elevation view of a support member within the apparatus of FIG. 1;

FIG. 3 is a diagrammatic elevation view of first and second reservoirs of the apparatus of FIG. 1;

FIG. 4 is a diagrammatic elevation view of a first container for the apparatus of FIG. 1;

FIG. 4a is a diagrammatic plan view of an element of FIG. 4;

FIG. 5 is a diagrammatic elevation view, partly in section of the container of FIG. 4 mounted on the support member of FIG. 2 in the apparatus of FIG. 1; and

FIG. 6 is a diagrammatic elevation view of a sight port in the apparatus of FIG. 1.

With reference to FIG. 1, apparatus for remote handling according to the invention comprises a cylindrical steel housing 10 closed at both ends, 30 inches in inside diameter. The cylinder is positioned on its side with its longitudinal axis horizontal in the sense of FIG. 1. A generally circular support member 20 is disposed across the cylinder cavity and is used to support various elements of the apparatus as described below. Support member 20 is conveniently releasably secured in housing 10 by any conventional mechanical fasteners such as by a several bolts 21 extending into housing 10 through flanges 22 provided at the periphery of member 20.

The device includes a first container 30 for receiving first and second materials from first and second reservoirs, the reservoirs being omitted from FIG. 1 in order to show more clearly the operation of the first container. The first container and the reservoirs are shown in more detail in FIGS. 3-5 which will be described below. As shown in FIG. 1, first container 30 is mounted in housing 10 on an elongate support member 31 extending transverse to the plane of the drawing. Member 31 is rotatably mounted about its longitudinal axis and permits movement of first container 30 about that axis.

A second container 50 is also provided in the housing and is moveably supported on support member 20 via flanged holder 54. Support member 20 includes two flanges 23, 24 extending outwardly from one side of member 20. Flanges 23 and 24 carry a rod member 25 which pivotally supports arm member 51. Second container 50 is secured to one end of arm 51 by means of bolts 52 extending through slots 53 in arm 51 into flange 54 of container 50. The bolts loosely engage arm 51 and thus permit a limited amount of vertical (in the sense of the drawing) motion of container 50 in housing 10, the extent of that motion being determined by the length of slots 53. On the side of member 20 opposite from flanges 23, 24, a support platform 26 is provided for supporting an agitator 70. Agitator 70 includes a solenoid-actuated arm 71 extending upwardly adjacent the bottom of container 50. On actuation of the solenoid, arm 71 reciprocates thus imparting a generally vertical vibrating motion to container 50 through aperture 62a in flange 54.

Arm 51 is provided at its other end with a counter weight 55 adjustably secured thereto by a conventional mechanical fastener comprising two plates 57 joined by a bolt 58. The counter weight is fixed in position on

arm 51 such that, with container 50 charged with a pre-determined amount of mixed material, arm 51, if free to move, would pivot clockwise in the sense of FIG. 1 to position 59 as shown in phantom.

Arm 51 is held in the horizontal position shown in FIG. 1 by means of a solenoid arm 60 of a solenoid 61 positioned on a platform 64 welded to member 20. Solenoid arm 60 extends into an aperture 62 in arm 51 to hold arm 51 in the position shown in FIG. 1. On actuation of solenoid 60, arm 61 is withdrawn from aperture 62 thus permitting clockwise rotation about member 25 under the influence of weight 55. A resilient stop member 65 is provided on support member 20 to arrest arm 51 in position 59 shown in phantom. Support member 20 is also provided with a latch member 28 engageable with a rod 63 extending outwardly from weight 55 to secure arm 51 in position 59 shown in phantom.

It will be seen that, on motion of arm 51, container 50 will move from a first position to the left of member 20 to a second position to the right of member 20 and member 20 is provided with a suitable aperture 29 to permit movement of container 50. The position of container 50 to the left in FIG. 1 is a material receiving position for receiving materials from first container 30. The position to the right in FIG. 1 is a material analysis position where the mixed materials may be analyzed. Housing 10 is provided at the analysis position with access to the analysis position. In the embodiment shown, the access comprises a sight port 11 described in more detail in connection with FIG. 3. While visual access to the analysis position of container 50 is illustrated, other types of access are contemplated such as mechanical, electrical or optical.

Materials transferred from the reservoirs to first container 30 are mixed in container 30 by first rotating container support member 31 about its longitudinal axis about 45° to position 32 indicated in phantom in FIG. 1. Container 30 is a cylinder open at its top and is mounted on member 31 rotatably about the cylinder axis. A motor 33 (see FIG. 5) is used to rotate the container about its cylindrical axis in inclined position 32 for mixing the materials therein in the fashion of a cement mixer. Container 30 is inclined generally about 45° from the vertical for mixing. However, the inclination may vary from that value and an inclination of from 20° to 70° from the vertical is suitable. Member 31 is movable about its longitudinal axis to rotate container 30 from its vertical position to inclined position 32 by means of a step motor 34 mounted on a support member 35 extending outwardly of support member 20. Step motor 34 also serves to rotate container 30 from inclined position 32 further clockwise to dump its contents into subadjacent container 50 when container 50 is positioned in its material receiving position. Preferably, step motor 34 moves container 30 to a substantially inverted position 36 and the apparatus includes a chute such as a funnel 80 having its discharge opening 81 adjacent an opening in container 50 for transferring the dumped materials into container 50. Preferably, funnel 80 is positioned in contact with container 50 or sufficiently close thereto such that it is contacted by container 50 when container 50 is agitated by solenoid arm 71. Thus, agitation imparted to container 50 facilitates discharge of material from funnel 80 to container 50. Similarly, container 30 is positioned at position 36 to be in contact with funnel 80 or to be contacted

thereby on agitation of funnel 80 to impart agitation to container 30 to facilitate discharge of material from container 30 to funnel 80.

After materials have been transferred to container 50, container 30 is then rotated further clockwise through position 37 to position 38. When at position 37, a bail engaging member 39 on container 30 engages a bail 82 provided at the upper edge of funnel 80. Further rotation of container 30 to position 38 causes funnel 80 to be moved upwardly to position 83 out of the path of motion of container 50 from its material receiving position to analysis position 50'. Ignition of the mixture is obtained at this point by conventional ignition device 27.

After analysis of the materials in container 50 at analysis position 50', such as by spectrographic analysis of combustion products, the apparatus is re-set to its original position either manually or remotely in any convenient manner. In most instances, manual resetting is practical because fresh materials to be mixed must be at least occasionally provided and because container 50 frequently has to be cleaned or changed. Housing 10 is thus generally provided with one or more suitable securable openings (not shown) for removal of container 50 and for the introduction of new materials for mixing. These openings are easily positioned to permit release of latch 28 for moving arm 51 back to its horizontal position and to permit relocation of funnel 80 as shown in FIG. 1. Mechanical resetting is, of course, equally feasible.

With reference to FIGS. 3-5, a first reservoir 90 comprises a hollow plastic cylinder closed at one end and having a plastic covered rubber stopper 91 sealing the other end. Barium metal powder is provided in the container in a glove box with argon atmosphere. A similar second reservoir 92 with rubber stopper 93 is provided with molybdenum trioxide powder. Each container is provided with an arm 94 secured to its closed end 95. Arms 94 are each in turn secured by nuts 96 to member 97 secured to solenoid arm 98 of solenoid 99 mounted on flange 100 secured to support member 20.

container 30 (FIGS. 4 and 5) comprises a base member 40, a tubular wall member 41 positioned above the base member, and a resilient reservoir holding member 42 interposed therebetween, the whole being retained together by a plurality of spring members 43 extending between wall member 41 and base member 40. Mixer motor 33 is mounted below member 31 by means of bolts extending through flanges 44 integral with the motor housing. Motor shaft 45 turns flange 46 secured to base portion 40 for rotating mixer container 30. Base portion 40 includes two integral studs 47 for positioning resilient member 42 adjacent the upper surface of base portion 40. Member 42 includes a recessed edge 48 for receiving the lower rim of tubular portion 41, apertures 49a for receiving studs 47, and apertures 49b for receiving stoppers 91 and 93 of reservoirs 90 and 92, respectively. As best shown in FIG. 4a, apertures 49b taper inwardly upwardly. The size and taper of aperture 49b is such that stoppers 91 and 93 each fit tightly within an aperture with the wide stopper surface flush with the wide opening of aperture 49b. Thus, stoppers 91 and 93 entirely fill apertures 49b such that on removal of reservoirs 90 and 92 no crevices exist at the apertures in which powdered material could be trapped.

The reservoirs containing the finely divided solid materials to be mixed are positioned in the apparatus by placing them with stoppers 91 and 93 down and on the upper surface of base member 40. Intermediate member 42 is then placed down over the reservoirs 90 and 92 such that they protrude through apertures 49b. Member 42 is then finally adjusted over studs 47 and moved downwardly into close adjacency with base member 40. Tubular member 41, preferably of transparent material such as glass or plastic, is then placed down on lip 48 of member 42 and the assembly held in place by a plurality of spring clamps 43. The inner wall of member 41 is preferably provided with several baffles extending radially inwardly a short distance, for example up to about 25 percent of the container radius. These baffles assist in mixing when container 30 is rotated about its cylindrical axis as described above. The assembly in housing 10 appears as shown in FIG. 5 with members 94 extending upwardly from reservoirs 90 and 92. Members 94 are then connected by nuts 96 to member 97 of solenoid 99 (FIG. 3). Solenoid arm 98, member 97, and reservoirs 90 and 92 are positioned such that on actuation of solenoid 99 to raise solenoid arm 98, reservoirs 90 and 92 are raised away from the bottom of mixer container 30 such that the solid particulate contents are discharged into the container. Solenoid arm 98 moves a distance sufficient that reservoirs 90 and 92 are moved upwardly a distance sufficient to permit rotation of container 30 as shown in FIG. 1.

After reservoirs 90 and 92 are raised, motor 34 is energized to rotate member 31 about its longitudinal axis to rotate container 30 to position 32 shown in FIG. 1 or about 45° to the vertical. Motor 33 is then energized to rotate container 30 about its cylindrical axis for a time sufficient to mix the materials. Motor 33 is then de-energized to stop rotation of container 30 and motor 34 is energized to move container 30 clockwise to position 36 (FIG. 1) at which position substantially all of the material has been dumped into funnel 80. Agitator 70 is then actuated which vibrates second container 50, funnel 80 and first container 30, all as described above, to facilitate transfer of all of the powdered materials to container 50, in this embodiment a firing test canister.

After the assembly has been agitated for a suitable time, funnel 80 is removed out of the path of motion of container 50. This is accomplished by rotating container 30 clockwise by motor 34 to a suitable position such as 38. Container 30 includes a bail engaging member 39 positioned to engage a bail 82 provided on funnel 80. When container 30 is rotated clockwise to a position 37 (intermediate positions 36 and 38), member 39 engages bail 82 of funnel 80 thus moving funnel 80 generally upwardly to position 83 shown in FIG. 1. As funnel 80 is raised to position 83, its inner wall will contact an edge of container 30 thus causing funnel 80 to assume position 83 shown in phantom.

After funnel 80 is moved to position 83, solenoid 61 is actuated to withdraw plunger 60 from aperture 62 in arm 51 whereupon arm 51 rotates to position 59 positioning container 50 in its material analysis position 50' adjacent sight port 11. Motion of arm 51 can, of course, be effected by power rather than by gravity and any conventional motor can be used for the purpose. Some materials are sensitive to shock and, for handling these materials, a motorized system or a damped gravity system should be used instead of the illustrated

gravity-latching system. In that instance, agitation of the test cannister can be eliminated or set at a tolerable level.

With reference to FIG. 6, sight port 11 preferably includes a rotatable transparent disc 12 rotated by a motor 13 in housing 14. Disc housing 14 is removeably secured to housing 10 by brackets 15, 16 as shown. A port 17 is provided in disc housing 14 and the sides of disc 12 are close to the walls of housing 14. On rotation of member 12 past port 17, a clear area of member 12 is continuously interposed into the optical path through the sight port. Motor 13 conveniently turns member 12 past part 17 at a rate such that the one revolution or less of disc 12 occurs during any one period of observation. The disc housing is easily removed using mounted brackets 15 and 16.

The apparatus is usually provided with suitable means for regulating the atmosphere in housing 10 such as vacuum pump 18 illustrated in FIG. 1. Alternatively, an inert atmosphere may be provided. In either event, conventional equipment is used and this may be disposed either inside or outside the housing. As shown in FIG. 6, the apparatus may include an analysis device such as a conventional spectrographic analysis device 19 mounted adjacent access port 11.

Further sight ports, such as sight port 11, can also be provided at other areas of the housing for observation of other positions in the housing such as the mixing operation. Mirrors can be placed at suitable locations in the housing to facilitate this observation.

In the illustrated embodiment, two reservoirs were provided for mixing two materials. It will be apparent that each reservoir may be provided with a single material, two or more materials, either pre-mixed or not. It will also be understood that three or more reservoirs may be employed.

What is claimed is:

1. Apparatus for the remote handling of materials comprising:

a closed housing;

first reservoir means for storing a first material in said housing;

second reservoir means for storing a second material in said housing;

a first container for mixing said first and second materials;

means for transferring said first and second materials from said first and second reservoirs, respectively, to said first container;

means for mixing said first and second materials in said first container;

a second container for receiving mixed materials and movably mounted within said housing from a material receiving position to a material analysis position, both of said positions being within said housing;

means for transferring the mixed materials from said first container to said second container when said second container is positioned at said material receiving position; and

means for moving said second container from said material receiving position to said material analysis position to bring the mixed materials into said material analysis position.

2. Apparatus according to claim 1 including means for controlling the atmosphere in said housing.

3. Apparatus according to claim 2 wherein said atmosphere controlling means comprises means for evacuating said housing.

4. Apparatus according to claim 1 wherein said housing includes access means adjacent said material analysis position for access to said position from outside said housing.

5. Apparatus according to claim 4 wherein said housing is opaque and wherein said access means comprises a transparent sight port.

6. Apparatus according to claim 5 wherein said transparent sight port comprises a rotatable transparent member adjacent the housing and means for rotating said member for maintaining visibility of said material handling position by moving clean portions of said transparent member into an optical path through said sight port.

7. Apparatus according to claim 1 including chute means interposed between said first container and said second container when said second container is positioned in said material receiving position, the discharge opening of said chute means being positioned adjacent an opening in said second container for conveying material into said second container and the entry opening of said chute means being positioned below said first container.

8. Apparatus according to claim 7 including means for agitating said chute means to facilitate transfer of said first and second materials to said second container.

9. Apparatus according to claim 8 wherein said chute means is positioned to contact said second container when said second container is positioned in said material receiving position and wherein said agitating means comprises means for vibrating said second container.

10. Apparatus according to claim 9 wherein said chute means contacts said first container when said first container is positioned in said material discharging position whereby the agitation imparted to said chute means is also imparted to said first container.

11. Apparatus according to claim 7 wherein said chute mean comprises a funnel.

12. Apparatus according to claim 1 wherein said first container is moveable from a material receiving position for receiving materials from said first and second reservoirs to a material discharging position wherein said material is discharged to said material transferring means, and wherein said apparatus includes means for moving said first container from said material receiving position to said material discharging position.

13. Apparatus according to claim 12 wherein said first container is further moveable from said material discharging position to said material receiving position, and said apparatus includes means for moving said first container from said material discharging position to said material receiving position, and means for moving said material transferring means from a material transferring position between said first and second containers to a remote position spaced from said second container a distance sufficient to permit said second container to be moved from said material receiving position to said material analysis position.

14. Apparatus according to claim 13 wherein said first container is cylindrical and is vertically oriented in said material receiving position.

15. Apparatus according to claim 14 wherein said first container is mounted for rotation about an axis

transverse to its longitudinal axis, and wherein said means for moving said first container between said material receiving position and said material discharging position and for further moving said second container between said material discharging position and said material receiving position comprise means for moving said first container about said transverse axis.

16. Apparatus according to claim 15 wherein said first container is rotatable about its longitudinal axis and is moveable about said transverse axis to a material mixing position wherein the longitudinal axis is inclined at an acute angle of from 20° to 70° with respect to the vertical, said apparatus including means for moving said first container from said material receiving position to said material mixing position and means for rotating said first container about said longitudinal axis.

17. Apparatus according to claim 16 wherein said means for moving said first container from said material receiving position to said material mixing position comprises means for moving said first container about said transverse axis.

18. Apparatus according to claim 13 wherein said means for moving said material transferring means comprises a bail secured to said material transferring means and said first container includes a bail engaging member adapted to engage said bail on motion of said first container from said material discharging position to said material receiving position.

19. Apparatus according to claim 1 wherein said first and second reservoir means comprise first and second receptacles positioned within said first container, said apparatus further including means for discharging the contents from said first and second receptacles into said first container.

20. Apparatus according to claim 19 wherein said receptacles comprise inverted cup-shaped members, the cups releasably secured to the bottom of said first container, said material discharging means comprising means for moving said cup members vertically with respect to the bottom wall of said first container.

21. Apparatus according to claim 1 wherein said housing is opaque, said housing including means for visually observing mixing of said first and second materials in said first container.

22. Apparatus according to claim 1 wherein said housing includes a fixed support member, said second container being moveable from said material receiving position on one side of said fixed support member to said material analysis position on the other side of said fixed support member.

23. Apparatus according to claim 22 wherein said fixed support member extends substantially across the inside of said housing, said member including an aperture to accommodate the movement of said second container between said material receiving position and said material analysis position.

24. Apparatus according to claim 23 wherein said second container is pivotally mounted for motion through said aperture.

25. Apparatus according to claim 1 further including means to ignite the materials within said second container when said second container is positioned at said material analysis position.

26. Apparatus according to claim 25 further including spectrograph means to analyze the ignition of said materials.